

**Water Quality Assessment
Lone Tree Creek
Arapahoe County Water and Wastewater Authority
Lone Tree Creek Water Reuse Facility (WRF)**

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I. Water Quality Assessment Summary

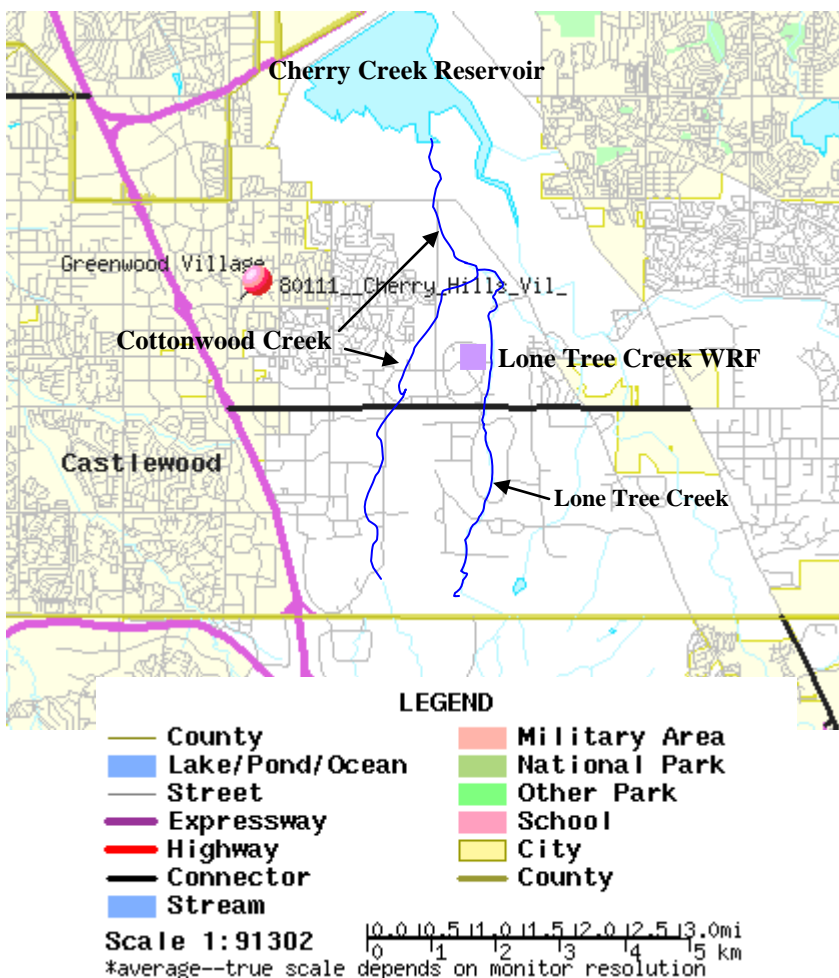
Table A-1 includes summary information related to this WQA. This summary table includes key regulatory starting points used in development of the WQA such as: receiving stream information; threatened and endangered species; 303(d) and Monitoring and Evaluation listings; low flow and facility flow summaries; and a list of parameters evaluated.

Table A-1 WQA Summary					
Facility Information					
Facility Name			Permit Number	Design Flow (max 30-day ave, MGD)	Design Flow (max 30-day ave, CFS)
F1. Lone Tree Creek Water Reuse Facility			CO0040681	3.6	5.6
Receiving Stream Information					
Receiving Stream Name		Segment ID	Designation	Classification(s)	
S1. Lone Tree Creek		COSPCH04	Use Protected	Aquatic Life Warm 2 Recreation Class E Agriculture	
Low Flows (cfs)					
1E3 (1-day)	7E3 (7-day)	30E3 (30-day)	Ratio of 30E3 to the Design Flow (cfs)		
S1. 0.5	0.5	0.5	F1: 0.09:1		
Regulatory Information					
T&E Species	303(d) (Reg 93)	Monitor and Eval (Reg 93)	Existing TMDL	Temporary Modification(s)	Control Regulation
No	Selenium	None	None	None	Regulation 72
Pollutants Evaluated					
F1: Ammonia, E. Coli, TRC, Metals, Temp, SAR, EC					

II. Introduction

The water quality assessment (WQA) of Lone Tree Creek near the Lone Tree Creek Water Reuse Facility (WRF), located in Arapahoe County, is intended to determine the assimilative capacities available for pollutants found to be of concern. This WQA describes how the water quality based effluent limits (WQBELs) are developed. These parameters may or may not appear in the permit with limitations or monitoring requirements, subject to other determinations such as reasonable potential analysis, evaluation of federal effluent limitation guidelines, implementation of state-based technology based limits, mixing zone analyses, 303(d) listings, threatened and endangered species listing, or other requirements as discussed in the permit rationale. Figure A-1 contains a map of the study area evaluated as part of this WQA.

Figure A-1
Study Area



Source: US Census Bureau, Tiger Map Server

The Lone Tree Creek WRF discharges to Lone Tree Creek, which is stream segment COSPCH04. This means the South Platte Basin, Cherry Creek Sub-basin, Stream Segment 04. This segment is composed of the “All tributaries to Cherry Creek, including all wetlands, from the source of East and West Cherry Creeks to the confluence with the South Platte River.”. Stream segment COSPCH04 is classified for Aquatic Life Warm 2, Recreation Class E, 0 and Agriculture.

The Lone Tree Creek WRF discharges to Lone Tree Creek, which originates at the Centennial Airport, approximately 2 miles upstream, and then joins Cottonwood Creek within one mile, which then flows into Cherry Creek Reservoir within another mile.

Cherry Creek Reservoir

Due to the proximity to the discharge point, Cherry Creek Reservoir, which is stream segment COSPCH02, would normally be considered. However, considering there is at least two miles to the reservoir, several confluences in the flow path, and the AD evaluation associated with Cherry Creek Reservoir was not applied to other permits in the same general vicinity, the Division has determined that Cherry Creek Reservoir will not be a part of this WQA.

Information used in this assessment includes data gathered from the Lone Tree Creek WRF, the Division, the Colorado Division of Water Resources (DWR), the U.S. Environmental Protection Agency (EPA), the U.S. Geological Survey (USGS), and communications with the local water commissioner. The data used in the assessment consist of the best information available at the time of preparation of this WQA analysis.

III. Water Quality Standards

Narrative Standards

Narrative Statewide Basic Standards have been developed in Section 31.11(1) of the regulations, and apply to any pollutant of concern, even where there is no numeric standard for that pollutant. Waters of the state shall be free from substances attributable to human-caused point source or nonpoint source discharges in amounts, concentrations or combinations which:

for all surface waters except wetlands;

(i) can settle to form bottom deposits detrimental to the beneficial uses. Depositions are stream bottom buildup of materials which include but are not limited to anaerobic sludge, mine slurry or tailings, silt, or mud; or (ii) form floating debris, scum, or other surface materials sufficient to harm existing beneficial uses; or (iii) produce color, odor, or other conditions in such a degree as to create a nuisance or harm existing beneficial uses or impart any undesirable taste to significant edible aquatic species or to the water; or (iv) are harmful to the beneficial uses or toxic to humans, animals, plants, or aquatic life; or (v) produce a predominance of undesirable aquatic life; or (vi) cause a film on the surface or produce a deposit on shorelines; and

for surface waters in wetlands;

(i) produce color, odor, changes in pH, or other conditions in such a degree as to create a nuisance or harm water quality dependent functions or impart any undesirable taste to significant edible aquatic species of the wetland; or (ii) are toxic to humans, animals, plants, or aquatic life of the wetland.

In order to protect the Basic Standards in waters of the state, effluent limitations and/or monitoring requirements for any parameter of concern could be put in CDPS discharge permits.

Standards for Organic Parameters and Radionuclides

Radionuclides: Statewide Basic Standards have been developed in Section 31.11(2) and (3) of The Basic Standards and Methodologies for Surface Water to protect the waters of the state from radionuclides and organic chemicals.

In no case shall radioactive materials in surface waters be increased by any cause attributable to municipal, industrial, or agricultural practices or discharges to as to exceed the following levels, unless alternative site-specific standards have been adopted. Standards for radionuclides are shown in Table A-2.

Table A-2 Radionuclide Standards	
Parameter	Picocuries per Liter
Americium 241*	0.15
Cesium 134	80
Plutonium 239, and 240*	0.15
Radium 226 and 228*	5
Strontium 90*	8
Thorium 230 and 232*	60
Tritium	20,000

*Radionuclide samples for these materials should be analyzed using unfiltered (total) samples. These Human Health based standards are 30-day average values for both plutonium and americium.

Organics: The organic pollutant standards contained in the Basic Standards for Organic Chemicals Table are applicable to all surface waters of the state for the corresponding use classifications, unless alternative site-specific standards have been adopted. These standards have been adopted as “interim standards” and will remain in effect until alternative permanent standards are adopted by the Commission. These interim standards shall not be considered final or permanent standards subject to antibacksliding or downgrading restrictions. Although not reproduced in this WQA, the specific standards for organic chemicals can be found in Regulation 31.11(3).

In order to protect the Basic Standards in waters of the state, effluent limitations and/or monitoring requirements for radionuclides, organics, or any other parameter of concern could be put in CDPS discharge permits.

The aquatic life standards for organics apply to all stream segments that are classified for aquatic life. The water supply standards apply only to those segments that are classified for water supply. The water + fish standards apply to those segments that have a Class 1 aquatic life and a water supply classification. The fish ingestion standards apply to Class 1 aquatic life segments that do not have a water supply designation. The water + fish and the fish ingestion standards may also apply to Class 2 aquatic life segments, where the Water Quality Control Commission has made such determination.

Because Lone Tree Creek is classified for Aquatic Life Warm 2 without a water supply designation, aquatic life standards apply to this discharge.

Salinity and Phosphorus

Phosphorus: Regulations 71, 72, 73 and 74, for Dillon Reservoir Watershed, Cherry Creek Reservoir Watershed, Chatfield Reservoir Watershed and the Bear Creek Watershed, contain requirements for phosphorus concentrations and phosphorus annual loadings for point source dischargers. If a facility discharges to one of these watersheds, a phosphorus allocation may be necessary, and limitations and annual loadings may be added to a permit.

Because the discharge from this facility ultimately impacts Cherry Creek Reservoir, it is subject to the *Cherry Creek Reservoir Control Regulation*, Regulation 72. This regulation imposes, by August 1, 2004, a total phosphorus concentration limitation of 0.05 mg/l on all dischargers to the reservoir. As of 2010, the WQCC removed all annual limitation language from the regulation. Therefore, a total maximum annual limitation (TMAL) is no longer required.

Salinity: Regulation 61.8(2)(l) contains requirements regarding salinity for any discharges to the Colorado River Watershed. For industrial dischargers and for the discharge of intercepted groundwater, this is a no-salt discharge requirement. However, the regulation states that this requirement may be waived where the salt load reaching the mainstem of the Colorado River is less than 1 ton per day, or less than 350 tons per year. The Division may permit the discharge of salt upon a satisfactory demonstration that it is not practicable to prevent the discharge of all salt. See Regulation 61.8(2)(l)(i)(A)(1) for industrial discharges and 61.8(2)(l)(iii) for discharges of intercepted groundwater for more information regarding this demonstration.

For municipal dischargers, an incremental increase of 400 mg/l above the flow weighted averaged salinity of the intake water supply is allowed. This may be waived where the salt load reaching the mainstem of the Colorado River is less than 1 ton per day, or less than 366 tons per year. The Division may permit the discharge of salt in excess of the 400 mg/l incremental increase, upon a satisfactory demonstration that it is not practicable to attain this limit. See Regulation 61.8(2)(l)(vi)(A)(1) for more information regarding this demonstration.

Regulation 75 contains requirements for the release of water from Cheraw Lake. Any entity releasing water from Cheraw Lake must ensure that either: 1) the water has a TDS concentration less than or equal to 4300 mg/l, or 2) that an adequate quantity of water of less saline nature can be supplied for dilution purposes such that a salinity level of 4300 ppm, measured as TDS, can be maintained in Horse Creek immediately above the first diversion below the confluence with the Cheraw Lake outlet channel.

In addition, the Division's policy, Implementing Narrative Standards in Discharge Permits for the Protection of Irrigated Crops, may be applied to discharges where an agricultural water intake exists downstream of a discharge point. Limitations for electrical conductivity and sodium absorption ratio may be applied in accordance with this policy.

Temperature

Temperature shall maintain a normal pattern of diurnal and seasonal fluctuations with no abrupt changes and shall have no increase in temperature of a magnitude, rate, and duration deemed deleterious to the resident aquatic life. This standard shall not be interpreted or applied in a manner inconsistent with section 25-8-104, C.R.S.

Segment Specific Numeric Standards

Numeric standards are developed on a basin-specific basis and are adopted for particular stream segments by the Water Quality Control Commission. The standards in Table A-3 have been assigned to stream segment COSPCH04 in accordance with the *Classifications and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin*.

**Table A-3
In-stream Standards**

<i>Physical and Biological</i>
Dissolved Oxygen (DO) = 5 mg/l, minimum
pH = 6.5 - 9 su
E. coli chronic = 126 colonies/100 ml
Temperature March-Nov = 27.5° C MWAT and 28.6° C DM
Temperature Dec-Feb = 13.8° C MWAT and 14.3° C DM
<i>Inorganic</i>
Total Ammonia acute and chronic = TVS
Chlorine acute = 0.019 mg/l
Chlorine chronic = 0.011 mg/l
Free Cyanide acute = 0.005 mg/l
Sulfide chronic = 0.002 mg/l
Boron chronic = 0.75 mg/l
Nitrite acute = 0.05 mg/l
Nitrate acute = 100 mg/l
<i>Metals</i>
Dissolved Arsenic acute = 340 µg/l
Total Recoverable Arsenic chronic = 100 µg/l (COSPCH04)
Dissolved Cadmium acute and chronic = TVS
Dissolved Trivalent Chromium acute and chronic = TVS
Dissolved Hexavalent Chromium acute and chronic = TVS
Dissolved Copper acute and chronic = TVS
Total Recoverable Iron chronic = 1000 µg/l
Dissolved Lead acute and chronic = TVS
Dissolved Manganese acute and chronic = TVS
Total Recoverable Molybdenum chronic = 210 µg/l
Total Mercury chronic = 0.01 µg/l
Dissolved Nickel acute and chronic = TVS
Dissolved Selenium acute and chronic = TVS
Dissolved Silver acute and chronic = TVS
Dissolved Zinc acute and chronic = TVS
Nonylphenol acute = 28 µg/l
Nonylphenol chronic = 6.6 µg/l

Table Value Standards and Hardness Calculations

Standards for metals are generally shown in the regulations as Table Value Standards (TVS), and these often must be derived from equations that depend on the receiving stream hardness or species of fish present; for ammonia, standards are discussed further in Section IV of this WQA. The Classification and Numeric Standards documents for each basin include a specification for appropriate hardness values to be used. Specifically, the regulations state that:

The hardness values used in calculating the appropriate metal standard should be based on the lower 95% confidence limit of the mean hardness value at the periodic low flow criteria as determined from a regression analysis of site-specific data. Where insufficient site-specific data exists to define the mean hardness value at the periodic low flow criteria, representative regional data shall be used to perform the regression analysis. Where a regression analysis is not appropriate, a site-specific method should be used.

Hardness data for Lone Tree Creek near the point of discharge of the Lone Tree Creek WRF were insufficient to conduct a regression analysis based on the low flow. Therefore, the Division's alternative approach to calculating hardness was used, which involves computing a mean hardness.

The mean hardness was computed to be 326 mg/l based on sampling data for alkalinity from sampling location LTC #3 (from the Lone Tree Creek WRF) located on Lone Tree Creek ½ mile upstream from the Lone Tree Creek wastewater treatment facility. Data were available for a period of record from January 2006 through October 2007.

This hardness value and the formulas contained in the TVS were used to calculate the in-stream water quality standards for metals, with the results shown in Table A-4.

Total Maximum Daily Loads and Regulation 93 – Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List

This stream segment is on the 303(d) list of water quality impacted streams for selenium.

For a receiving water placed on this list, the Restoration and Protection Unit is tasked with developing the Total Maximum Daily Loads (TMDLs) and the Waste Load Allocation (WLAs) to be distributed to the affected facilities. WLAs for selenium have not yet been established and the allowable concentration calculated in the following sections may change upon further evaluation by the Division.

Table A-4 TVS-Based Metals Water Quality Standards for CO0040681 Based on the Table Value Standards Contained in the Colorado Department of Public Health and Environment Water Quality Control Commission <i>Regulation 38</i>			
<i>Parameter</i>	<i>In-Stream Water Quality Standard</i>		<i>TVS Formula:</i> <i>Hardness (mg/l) as CaCO3 = 326</i>
Aluminum, Total Recoverable	Acute	10071 µg/l	$e^{(1.3695(\ln(\text{hardness}))+1.8308)}$
	Chronic	1438 µg/l	$e^{(1.3695(\ln(\text{hardness}))-0.1158)}$
Cadmium, Dissolved	Acute	7.7 µg/l	$[1.136672-0.041838\ln(\text{hardness})]e^{(0.9151(\ln(\text{hardness}))-3.1485)}$
	Chronic	1 µg/l	$[1.101672-0.041838\ln(\text{hardness})]e^{(0.7998(\ln(\text{hardness}))-4.4451)}$
Trivalent Chromium, Dissolved	Acute	1500 µg/l	$e^{(0.819(\ln(\text{hardness}))+2.5736)}$
	Chronic	195 µg/l	$e^{(0.819(\ln(\text{hardness}))+0.5340)}$
Hexavalent Chromium, Dissolved	Acute	16 µg/l	Numeric standards provided, formula not applicable
	Chronic	11 µg/l	Numeric standards provided, formula not applicable
Copper, Dissolved	Acute	41 µg/l	$e^{(0.9422(\ln(\text{hardness}))-1.7408)}$
	Chronic	25 µg/l	$e^{(0.8545(\ln(\text{hardness}))-1.7428)}$
Lead, Dissolved	Acute	227 µg/l	$[1.46203-0.145712\ln(\text{hardness})][e^{(1.273(\ln(\text{hardness}))-1.46)}]$
	Chronic	8.9 µg/l	$[1.46203-0.145712\ln(\text{hardness})][e^{(1.273(\ln(\text{hardness}))-4.705)}]$
Manganese, Dissolved	Acute	4426 µg/l	$e^{(0.3331(\ln(\text{hardness}))+6.4676)}$
	Chronic	2445 µg/l	$e^{(0.3331(\ln(\text{hardness}))+5.8743)}$
Nickel, Dissolved	Acute	1272 µg/l	$e^{(0.846(\ln(\text{hardness}))+2.253)}$
	Chronic	141 µg/l	$e^{(0.846(\ln(\text{hardness}))+0.0554)}$
Selenium, Dissolved	Acute	18.4 µg/l	Numeric standards provided, formula not applicable
	Chronic	4.6 µg/l	Numeric standards provided, formula not applicable
Silver, Dissolved	Acute	15 µg/l	$\frac{1}{2} e^{(1.72(\ln(\text{hardness}))-6.52)}$
	Chronic	2.4 µg/l	$e^{(1.72(\ln(\text{hardness}))-9.06)}$
Zinc, Dissolved	Acute	393 µg/l	$0.978e^{(0.8525(\ln(\text{hardness}))+1.0617)}$
	Chronic	340 µg/l	$0.986 e^{(0.8525(\ln(\text{hardness}))+0.9109)}$

IV. Receiving Stream Information

Low Flow Analysis

The Colorado Regulations specify the use of low flow conditions when establishing water quality based effluent limitations, specifically the acute and chronic low flows. The acute low flow, referred to as 1E3, represents the one-day low flow recurring in a three-year interval, and is used in developing limitations based on an acute standard. The 7-day average low flow, 7E3, represents the seven-day average low flow recurring in a 3 year interval, and is used in developing limitations based on a Maximum Weekly Average Temperature standard (MWAT). The chronic low flow, 30E3, represents the 30-day average low flow recurring in a three-year interval, and is used in developing limitations based on a chronic standard.

To determine the low flows available to the Lone Tree Creek WRF, an upstream gage should be used. There were no gage stations located upstream or downstream of the facility and no nearby gage stations for comparable streams.

Lone Tree Creek originates approximately 2 miles upstream of the Lone Tree Creek WRF at the Centennial Airport. Due to nearby irrigation and airport operations, the facility indicates that there is stream flow year round in Lone Tree Creek. This was verified via the in-stream study involving weekly monitoring by the facility. The field survey and investigation conducted by the Lone Tree Creek WRF for the previous WQA (2005) was used to establish an annual low flow of 0.5 cfs. The local water commissioner was called upon to confirm the estimated low flows but was unfamiliar with the stream.

For purposes of this assessment and based on the low flow analysis described previously, the upstream low flows available to the Lone Tree Creek WRF were determined and are presented in Table A-5.

Table A-5													
Low Flows for Lone Tree Creek at the Lone Tree Creek (WRF)													
<i>Low Flow (cfs)</i>	<i>Annual</i>	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>
1E3 Acute	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
7E3 Chronic	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
30E3 Chronic	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50

The ratio of the low flow of Lone Tree Creek to the Lone Tree Creek WRF design flow is 0.09:1.

Mixing Zones

The amount of the available assimilative capacity (dilution) that may be used by the permittee for the purposes of calculating the WQBELs may be limited in a permitting action based upon a mixing zone analysis or other factor. These other factors that may reduce the amount of assimilative capacity available in a permit are: presence of other dischargers in the vicinity; the presence of a water diversion downstream of the discharge (in the mixing zone); the need to provide a zone of passage for aquatic life; the likelihood of bioaccumulation of toxins in fish or wildlife; habitat considerations such as fish spawning or nursery areas; the presence of threatened and endangered species; potential for human exposure through drinking water or recreation; the possibility that aquatic life will be attracted to the effluent plume; the potential for adverse effects on groundwater; and the toxicity or persistence of the substance discharged.

Unless a facility has performed a mixing zone study during the course of the previous permit, and a decision has been made regarding the amount of the assimilative capacity that can be used by the facility, the Division assumes that the full assimilative capacity can be allocated. Note that the review of mixing study considerations, exemptions and perhaps performing a new mixing study (due to changes in low flow, change in facility design flow, channel geomorphology or other reason) is evaluated in every permit and permit renewal.

If a mixing zone study has been performed and a decision regarding the amount of available assimilative capacity has been made, the Division may calculate the water quality based effluent limitations (WQBELs) based on this available capacity. In addition, the amount of assimilative capacity may be reduced by T&E implications.

For this facility, 100% of the available assimilative capacity may be used as the facility has not had to perform a mixing zone study, the discharge is not to a T&E stream segment, and is not expected to have an influence on any of the other factors listed above.

Ambient Water Quality

The Division evaluates ambient water quality based on a variety of statistical methods as prescribed in Section 31.8(2)(a)(i) and 31.8(2)(b)(i)(B) of the *Colorado Department of Public Health and Environment Water Quality Control Commission Regulation No. 31*, and as outlined in the Division's Policy for Characterizing Ambient Water Quality for Use in Determining Water Quality Standards Based Effluent Limits (WQP-19). Ambient water quality is evaluated in this WQA analysis for use in determining assimilative capacities and in completing antidegradation reviews for pollutants of concern, where applicable.

To conduct an assessment of the ambient water quality upstream of the Lone Tree Creek (WRF), data were gathered from Lone Tree WRF sampling location LTC #3, located approximately ½ mile upstream from the facility. Data for pH and temperature were available for a period of record from January 2006 through October 2007. Data for chloride were available for a period of record from October 2006 through February 2007. Data for selenium were available for a period of record from January 2010 through May 2012.

For other parameters, a comparable watershed was used in the absence of upstream or downstream data for Lone Tree Creek. Cottonwood Creek, which Lone Tree Creek flows into prior to the

confluence with Cherry Creek Reservoir, is comparable to the upper reaches of Lone Tree Creek. Data were gathered from USGS water quality station 06712960 (Cottonwood Creek Above Cherry Creek Lake, CO). Data from this location were available for a period of record from February 1982 through October 1986. Data for *E. coli* were also gathered from USGS water quality station 393613104511401 (Cottonwood Ck Ab Newark Wy at Greenwood Village, CO). Data from this location were available for a period of record from June 2003 through August 2003.

These data were combined to represent the upstream ambient water quality in Lone Tree Creek near the Arapahoe County Water and Wastewater Authority WRF and are summarized in Table A-6.

Table A-6 Ambient Water Quality for Lone Tree Creek								
<i>Parameter</i>	<i># of Samples</i>	<i>15th Percentile</i>	<i>50th Percentile</i>	<i>85th Percentile</i>	<i>Mean</i>	<i>Maximum</i>	<i>Chronic Stream Standard</i>	<i>Notes</i>
Temp (°C)	7	0.81	9.6	17	9.9	25	NA	
pH (su)	7	8.1	8.2	8.3	8.2	8.3	6.5-9	
<i>E. coli</i> (#/100 ml)	2	419	440	461	439	470	126	1, 3
Nitrate as N (mg/l)	2	0.66	0.74	0.82	0.74	0.85	100	
Nitrite as N (mg/l)	12	0	0.02	0.05	0.023	0.07	0.05	2
Nitrate+Nitrite as N (mg/l)	43	0.3	0.4	0.68	0.5	1.7	NA	
NH ₃ as N, Tot (mg/l)	43	0	0.07	0.13	0.07	0.21	TVS	2
As, Dis (µg/l)	1	1	1	1	1	1	340	
Cd, Dis (µg/l)	11	0	0	0	0	0	1.00	2
Cr, TR (µg/l)	1	3	3	3	3	3	NA	
Cu, Dis (µg/l)	11	0	0	0	0	0	25	2
Fe, TR (µg/l)	10	665	2965	33480	17654	100000	1000	3
Pb, Dis (µg/l)	11	0	0	0	0	0	8.90	2
Mn, Dis (µg/l)	11	0	20	65	29	120	2445	2
Hg, Tot (µg/l)	1	0.2	0.2	0.2	0.2	0.2	0.01	3
Ni, TR (µg/l)	1	6	6	6	6	6	NA	
Se, Dis (µg/l)	29	19	31	39	30	57	4.6	3
Ag, TR (µg/l)	1	0	0	0	0	0	NA	2
Zn, Dis (µg/l)	11	0	0	5	2.7	20	340	2
Chloride (mg/l)	2	280	395	511	395	560	250	3
Hardness as CaCO ₃ (mg/l)	7	295	328	349	326	360	NA	
Note 1: The calculated mean is the geometric mean. Note that for summarization purposes, the value of one was used where there was no detectable amount because the geometric mean cannot be calculated using a value equal to zero.								
Note 2: When sample results were below detection levels, the value of zero was used in accordance with the Division's standard approach for summarization and averaging purposes.								
Note 3: The ambient water quality exceeds the water quality standards for these parameters.								

V. Facility Information and Pollutants Evaluated

Facility Information

The Lone Tree Creek WRF is located at in the SW 1/4 of the NE 1/4 of S 24, T5S, R67W; 6250 South Uvalda Street in Centennial, CO; at 39° 36' 08.00" latitude North, 104° 50'09.40" longitude West in Arapahoe County. The current design capacity of the facility is 3.6 MGD (5.6 cfs). Wastewater treatment is accomplished using a mechanical wastewater treatment process. The technical analyses that follow include assessments of the assimilative capacity based on this design capacity.

An assessment of Division records indicate that there are a few facilities discharging to the same stream segment or other stream segments immediately upstream or downstream from this facility. All of these facilities are covered by general permits and have limitations set at the water quality standards. These facilities were not modeled in this WQA as they have a minimal impact on the ambient water quality.

The Lone Tree Creek WRF is the sole known point source contributor not covered by a general permit to Lone Tree Creek. No other point sources were identified as dischargers to Lone Tree Creek upstream or downstream of the confluence with Cottonwood Creek. Note that due to the intermittent nature of stormwater discharges, and that these types of discharges do not typically occur at low flow conditions, they are not considered in this WQA.

Pollutants of Concern

Pollutants of concern may be determined by one or more of the following: facility type; effluent characteristics and chemistry; effluent water quality data; receiving water quality; presence of federal effluent limitation guidelines; or other information. Parameters evaluated in this WQA may or may not appear in a permit with limitations or monitoring requirements, subject to other determinations such as a reasonable potential analysis, mixing zone analyses, 303(d) listings, threatened and endangered species listings or other requirement as discussed in a permit rationale.

There are no site-specific in-stream water quality standards for BOD₅ or CBOD₅, TSS, percent removal, and oil and grease for this receiving stream. Thus, assimilative capacities were not determined for these parameters. The applicable limitations for these pollutants can be found in Regulation No. 62 and will be applied in the permit for the WRF.

The following parameters were identified by the Division as pollutants to be evaluated for this facility:

- Total Residual Chlorine
- *E. coli*
- Nitrate, Nitrite
- Chloride
- Ammonia
- Nonylphenol
- Sulfide
- Temperature
- SAR and EC
- Metals and Cyanide

It is the Division's standard procedure to consider metals and cyanide as potential pollutants of concern for all major domestic WRFs.

During assessment of the facility, nearby facilities, and receiving stream water quality, no additional parameters were identified as pollutants of concern.

VI. Determination of Water Quality Based Effluent Limitations (WQBELs)

Technical Information

Note that the WQBELs developed in the following paragraphs, are calculations of what an effluent limitation may be in a permit. The WQBELs for any given parameter, will be compared to other potential limitations (federal Effluent Limitations Guidelines, State Effluent Limitations, or other applicable limitation) and typically the more stringent limit is incorporated into a permit. If the WQBEL is the more stringent limitation, incorporation into a permit is dependent upon a reasonable potential analysis.

In-stream background data and low flows evaluated in Sections II and III are used to determine the assimilative capacity of Lone Tree Creek near the Lone Tree Creek WRF for pollutants of concern, and to calculate the WQBELs. For all parameters except ammonia, it is the Division's approach to calculate the WQBELs using the lowest of the monthly low flows (referred to as the annual low flow) as determined in the low flow analysis. For ammonia, it is the standard procedure of the Division to determine monthly WQBELs using the monthly low flows, as the regulations allow the use of seasonal flows.

The Division's standard analysis consists of steady-state, mass-balance calculations for most pollutants and modeling for pollutants such as ammonia. The mass-balance equation is used by the Division to calculate the WQBELs, and accounts for the upstream concentration of a pollutant at the existing quality, critical low flow (minimal dilution), effluent flow and the water quality standard. The mass-balance equation is expressed as:

$$M_2 = \frac{M_3Q_3 - M_1Q_1}{Q_2}$$

Where,

Q_1 = Upstream low flow (1E3 or 30E3)

Q_2 = Average daily effluent flow (design capacity)

Q_3 = Downstream flow ($Q_1 + Q_2$)

M_1 = In-stream background pollutant concentrations at the existing quality

M_2 = Calculated WQBEL

M_3 = Water Quality Standard, or other maximum allowable pollutant concentration

The upstream background pollutant concentrations used in the mass-balance equation will vary based on the regulatory definition of existing ambient water quality. For most pollutants, existing quality is determined to be the 85th percentile. For metals in the total or total recoverable form, existing quality is determined to be the 50th percentile. For pathogens such as fecal coliform and *E. coli*, existing quality is determined to be the geometric mean.

For temperature, the highest 7-day mean (for the chronic standard) of daily average stream temperature, over a seven consecutive day period will be used in calculations of the chronic temperature assimilative capacity, where the daily average temperature should be calculated from a minimum of three measurements spaced equally through the day. The highest 2-hour mean (for the acute standard) of stream temperature will be used in calculations of the acute temperature assimilative capacity. The highest 2-hour mean should be calculated from a minimum of 12 measurements spaced equally through the day.

Calculation of WQBELs

Using the mass-balance equation provided in the beginning of Section VI, the acute and chronic low flows set out in Section IV, ambient water quality as discussed in Section IV, and the in-stream standards shown in Section III, the WQBELs for were calculated. The data used and the resulting WQBELs, M_2 , are set forth in Table A-7a for the chronic WQBELs and A-7b for the acute WQBELs for COSPCH04.

When the ambient water quality exceeds the in-stream standard, the Division standard procedure is to allocate the water quality standard to prevent further degradation of the receiving waters.

Chlorine: There are no point sources discharging total residual chlorine within one mile of the Lone Tree Creek WRF. Because chlorine is rapidly oxidized, in-stream levels of residual chlorine are detected only for a short distance below a source. Ambient chlorine was therefore assumed to be zero.

***E. coli*:** There are no point sources discharging *E. coli* within one mile of the Lone Tree Creek (WRF). For *E. coli*, the Division establishes the 7-day geometric mean limit as two times the 30-day geometric mean limit and also includes maximum limits of 2,000 colonies per 100 ml (30-day geometric mean) and 4,000 colonies per 100 ml (7-day geometric mean). This 2000 colony

limitation also applies to discharges to ditches.

Temperature: A WQBEL for temperature can only be calculated if there is representative data, in the proper form, to determine what the background Maximum Weekly Average Temperature and Daily Maximum ambient temperatures are. As this data is not available at this time, the temperature limitation will be set at the water quality standard and will be revisited in the future when representative temperature data becomes available.

Table A-7a Chronic WQBELs: COSPCH04							
<i>Parameter</i>	<i>Q₁ (cfs)</i>	<i>Q₂ (cfs)</i>	<i>Q₃ (cfs)</i>	<i>M₁</i>	<i>M₃</i>	<i>M₂</i>	<i>Notes</i>
Temp MWAT (°C) March-Nov	0.5	5.6	6.1	NA	28	28	
Temp MWAT (°C) Dec-Feb	0.5	5.6	6.1	NA	14	14	
<i>E. coli</i> (#/100 ml)	0.5	5.6	6.1	439	126	126	1
TRC (mg/l)	0.5	5.6	6.1	0	0.011	0.012	
As, TR (µg/l)	0.5	5.6	6.1	0	1438	1566	
Cd, Dis (µg/l)	0.5	5.6	6.1	0	1.0	1.1	
Cr+3, Dis (µg/l)	0.5	5.6	6.1	3	195	212	
Cr+6, Dis (µg/l)	0.5	5.6	6.1	3	11	12	
Cu, Dis (µg/l)	0.5	5.6	6.1	0	25	27	
Fe, TR (µg/l)	0.5	5.6	6.1	2965	1000	1000	1
Pb, Dis (µg/l)	0.5	5.6	6.1	0	8.9	9.7	
Mn, Dis (µg/l)	0.5	5.6	6.1	65	2445	2658	
Hg, Tot (µg/l)	0.5	5.6	6.1	0.2	0.01	0.01	1
Ni, Dis (µg/l)	0.5	5.6	6.1	6	141	153	
Se, Dis (µg/l)	0.5	5.6	6.1	39	4.6	4.6	1
Ag, Dis (µg/l)	0.5	5.6	6.1	0	2.4	2.6	
Zn, Dis (µg/l)	0.5	5.6	6.1	5	340	370	
Chloride (mg/l)	0.5	5.6	6.1	511	250	250	1
Sulfide as H ₂ S (mg/l)	0.5	5.6	6.1	0	0.002	0.0022	
Nonylphenol (µg/l)	0.5	5.6	6.1	0	6.6	7.2	
Note 1: The existing water quality for this parameter exceeds the water quality standard; see the text for further discussion.							

Table A-7b Acute WQBELs: COSPCH02							
<i>Parameter</i>	<i>Q₁ (cfs)</i>	<i>Q₂ (cfs)</i>	<i>Q₃ (cfs)</i>	<i>M₁</i>	<i>M₃</i>	<i>M₂</i>	<i>Notes</i>
TRC (mg/l)	0.5	5.6	6.1	0	0.019	0.021	
Nitrate as N (mg/l)	0.5	5.6	6.1	0.82	100	109	
Nitrite as N (mg/l)	0.5	5.6	6.1	0.05	0.05	0.05	
As, Dis (µg/l)	0.5	5.6	6.1	1	340	370	
Cd, Dis (µg/l)	0.5	5.6	6.1	0	7.7	8.4	
Cr+3, Dis (µg/l)	0.5	5.6	6.1	3	1500	1634	
Cr+6, Dis (µg/l)	0.5	5.6	6.1	3	16	17	
Cu, Dis (µg/l)	0.5	5.6	6.1	0	41	45	
CN, Free (µg/l)	0.5	5.6	6.1	0	5	5.4	
Pb, Dis (µg/l)	0.5	5.6	6.1	0	227	247	
Mn, Dis (µg/l)	0.5	5.6	6.1	65	4426	4815	
Ni, Dis (µg/l)	0.5	5.6	6.1	6	1272	1385	
Se, Dis (µg/l)	0.5	5.6	6.1	39	18.4	18.4	1
Ag, Dis (µg/l)	0.5	5.6	6.1	0	15	16	
Zn, Dis (µg/l)	0.5	5.6	6.1	5	393	428	
Nonylphenol (µg/l)	0.5	5.6	6.1	0	28	31	
Note 1: The existing water quality for this parameter exceeds the water quality standard; see the text for further discussion.							

Ammonia: The Ammonia Toxicity Model (AMMTOX) is a software program designed to project the downstream effects of ammonia and the ammonia assimilative capacities available to each discharger based on upstream water quality and effluent discharges. To develop data for the AMMTOX model, an in-stream water quality study should be conducted of the upstream receiving water conditions, particularly the pH and corresponding temperature, over a period of at least one year.

There was not enough pH or temperature data available for Lone Tree Creek or the Lone Tree Creek WRF that could be used as adequate input data for the AMMTOX model. Therefore, the Division standard procedure is to rely on statistically-based, regionalized data for pH and temperature compiled from similar facilities and receiving waters.

Upstream ammonia data for each month were not available. Thus, the mean total ammonia concentration found in Lone Tree Creek as summarized in Table A-6 was used as an applicable upstream ammonia concentration reflective of each month.

The AMMTOX may be calibrated for a number of variables in addition to the data discussed above. The values used for the other variables in the model are listed below:

- Stream velocity = $0.3Q^{0.4d}$
- Default ammonia loss rate = 6/day

- pH amplitude was assumed to be medium
- Default times for pH maximum, temperature maximum, and time of day of occurrence
- pH rebound was set at the default value of 0.2 su per mile
- Temperature rebound was set at the default value of 0.7 degrees C per mile.

The results of the ammonia analyses for the Lone Tree Creek WRF are presented in Table A-8.

Table A-8 AMMTOX Results for Lone Tree Creek at the Lone Tree Creek (WRF)		
<i>Design of 3.6 MGD (5.6 cfs)</i>		
<i>Month</i>	<i>Total Ammonia Chronic (mg/l)</i>	<i>Total Ammonia Acute (mg/l)</i>
January	4.2	18
February	3.4	12
March	3.4	14
April	3.5	16
May	2.9	14
June	2.6	15
July	2.3	15
August	2.1	13
September	2.1	13
October	2.6	14
November	3.3	16
December	3.7	15

Agricultural Use Parameters (SAR and EC):

Section 31.11(1)(a)(iv) of *The Basic Standards and Methodologies for Surface Waters* (Regulation No. 31) includes the narrative standard that State surface waters shall be free of substances that are harmful to the beneficial uses or toxic to humans, animals, plants, or aquatic life. The interpretation of these conditions (i.e., “no harm to plants” and “no harm to the beneficial uses”) and how they were to be applied in permits were contemplated by the Division as part of an Agricultural Work Group, and culminated in the most recent policy entitled *Implementing Narrative Standards in Discharge Permits for the Protection of Irrigated Crops* (hereafter the Narrative Standards policy)

Based on available information, the water in **Lone Tree Creek** is used for irrigation water. However, the local water commissioner knows of no crops being irrigated with the receiving or downstream waters. Therefore, no agricultural use parameters will be a part of this WQA.

VII. Antidegradation Evaluation

As set out in *The Basic Standards and Methodologies for Surface Water*, Section 31.8(2)(b), an antidegradation analysis is required except in cases where the receiving water is designated as “Use Protected.” Note that “Use Protected” waters are waters “that the Commission has determined do

not warrant the special protection provided by the outstanding waters designation or the antidegradation review process” as set out in Section 31.8(2)(b). The antidegradation section of the regulation became effective in December 2000, and therefore antidegradation considerations are applicable to this WQA analysis.

According to the *Classifications and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin*, stream segment COSPCH04 is Use Protected. Because this receiving water is designated as Use Protected, no antidegradation review is necessary in accordance with the regulations.

VIII. Technology Based Limitations

Federal Effluent Limitation Guidelines

The Federal Effluent Limitation Guidelines for domestic wastewater treatment facilities are the secondary treatment standards. These standards have been adopted into, and are applied out of, Regulation 62, the Regulations for Effluent Limitations.

Regulations for Effluent Limitations

Regulation No. 62, the Regulations for Effluent Limitations, includes effluent limitations that apply to all discharges of wastewater to State waters, with the exception of storm water and agricultural return flows. These regulations are applicable to the discharge from the proposed discharge.

According to Part 62.4(2) of the Regulations for Effluent Limitations "If the Commission has not so promulgated effluent limitation guidelines for any particular industry, but that industry is subject to effluent limitation guidelines promulgated by the United States Environmental Protection Agency pursuant to the Federal Water Pollution Control Act of 1972, the effluent from these industries shall be subject to the applicable EPA guidelines and shall not be subject to the effluent limitations of Regulation 62.4.” Therefore, the limitation for oil and grease in Regulation 62.5 (10 mg/l) shall not apply to this discharge.

Table A-9 contains a summary of the applicable limitations for pollutants of concern at this facility.

Table A-9			
Regulation 62 Based Limitations			
<i>Parameter</i>	<i>30-Day Average</i>	<i>7-Day Average</i>	<i>Instantaneous Maximum</i>
BOD ₅	30 mg/l	45 mg/l	NA
BOD ₅ Percent Removal	85%	NA	NA
TSS, mechanical plant	30 mg/l	45 mg/l	NA
TSS Percent Removal	85%	NA	NA
Total Residual Chlorine	NA	NA	0.5 mg/l
pH	NA	NA	6.0-9.0 s.u.
Oil and Grease	NA	NA	10 mg/l

IX. References

Regulations:

The Basic Standards and Methodologies for Surface Water, Regulation 31, Colorado Department Public Health and Environment, Water Quality Control Commission, effective January 1, 2012.

Classifications and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin, Regulation No. 38, Colorado Department Public Health and Environment, Water Quality Control Commission, effective January 1, 2012.

Cherry Creek Reservoir Control Regulation, Regulation 72. Colorado Department Public Health and Environment, Water Quality Control Commission, effective January 1, 2010.

Regulations for Effluent Limitations, Regulation 62, CDPHE, WQCC, amended June 11, 2012, effective July 30, 2012.

Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List, Regulation 93, Colorado Department Public Health and Environment, Water Quality Control Commission, effective March 30, 2012.

Policy and Guidance Documents:

Antidegradation Significance Determination for New or Increased Water Quality Impacts, Procedural Guidance, Colorado Department Public Health and Environment, Water Quality Control Division, December 2001.

Memorandum Re: First Update to (Antidegradation) Guidance Version 1.0, Colorado Department Public Health and Environment, Water Quality Control Division, April 23, 2002.

Rationale for Classifications, Standards and Designations of Segments of the South Platte, Colorado Department Public Health and Environment, Water Quality Control Division, effective October 29, 2002.

Policy Concerning Escherichia coli versus Fecal Coliform, CDPHE, WQCD, July 20, 2005.

Colorado Mixing Zone Implementation Guidance, Colorado Department Public Health and Environment, Water Quality Control Division, effective April 2002.

Policy for Conducting Assessments for Implementation of Temperature Standards in Discharge Permits, Colorado Department Public Health and Environment, Water Quality Control Division Policy Number WQP-23, effective July 3, 2008.

Implementing Narrative Standards in Discharge Permits for the Protection of Irrigated Crops, Colorado Department Public Health and Environment, Water Quality Control Division Policy Number WQP-24, effective March 10, 2008.

Policy for Characterizing Ambient Water Quality for Use in Determining Water Quality Standards Based Effluent Limits, Colorado Department Public Health and Environment, Water Quality Control Division Policy Number WQP-19, effective May 2002.